**Topics: Normal distribution, Functions of Random Variables**

1. The time required for servicing transmissions is normally distributed with *μ* = 45 minutes and *σ* = 8 minutes. The service manager plans to have work begin on the transmission of a customer’s car 10 minutes after the car is dropped off and the customer is told that the car will be ready within 1 hour from drop-off. What is the probability that the service manager cannot meet his commitment?
2. 0.3875
3. 0.2676
4. 0.5
5. 0.6987

**ANS B**

The work begin start after 10 minutes so average time increases from 45 minutes to 55 minutes

So, loc=55, scale=8

And car will be ready within 1 hour means 60 minutes so x=60.

But we have to find probability that car cannot ready within 1 hour so find out

1 - stats.norm.cdf(60,loc=55,scale=8)

**= 0.26598552904870054**

Therefore option B is correct.

1. The current age (in years) of 400 clerical employees at an insurance claims processing center is normally distributed with mean *μ* = 38 and Standard deviation *σ* =6. For each statement below, please specify True/False. If false, briefly explain why.
2. More employees at the processing center are older than 44 than between 38 and 44.
3. A training program for employees under the age of 30 at the center would be expected to attract about 36 employees.

We have a normal distribution with mean(loc) = 38 and SD(scale) = 6.

**A**) We have to find probability that employees are older than 44 is

**1-stats.norm.cdf(44,loc=38,scale=6) = 0.15865525393145707 = 15.87%**

AND probability of employees less than 44 is ………………………..(equation 1)

**stats.norm.cdf(44,loc=38,scale=6) = 0.8413447460685429 = 84.13%**

Now, We have to find probability that employees are older than 38 is

**1-stats.norm.cdf(38,loc=38,scale=6) = 0.5 = 50%**

So the probability of number of employees between 38-44 years of age

= P(X<44) – P(X>38)

=84.1345 – 50% = 34.1345% …………………………………..(equation 2)

So on comparing equation 1 & 2 we get given statement is false

**Therefore the given statement is FALSE**

**B)**  Probabilty of employees less than age of 30 = Pr(X<30). Is

**stats.norm.cdf(30,loc=38,scale=6) = 0.09121121972586788**

So the number of employees with probability 0.0912 of them being under age 30

= 0.0912\*400

=36.48 ( or 36 employees).

=approximately equal to 36

**So, given statement is TRUE**

1. If *X1* ~ *N*(μ, σ2) and *X*2 ~ *N*(μ, σ2) are *iid* normal random variables, then what is the difference between 2 *X*1 and *X*1 + *X*2? Discuss both their distributions and parameters.

ANS: 2 X1 will be greater scale version than X1 + X2 . If X1 and X2 are normally distributed then the sum of the random sample will be exactly same

1. Let X ~ N(100, 202). Find two values, *a* and *b*, symmetric about the mean, such that the probability of the random variable taking a value between them is 0.99.
2. 90.5, 105.9
3. 80.2, 119.8
4. 22, 78
5. 48.5, 151.5
6. 90.1, 109.9

Given:  p(a<x<b) = 0.99 ,

mean =100, standardDeviation = 20

To Find:

Identify symmetric values for the standard normal distribution such that the area enclosed is .99

From the above details,we have to excluded area of .005 in each of the left and right tails. Hence, we want to find the 0.5th and the 99.5th x values so it gives the interval enclosed by 0.99 probability.

So**, stats.norm.ppf(0.005,loc=100,scale=20) = 48.483413929021985**

And**, stats.norm.ppf(0.995,100,20) = 151.516586070978**

Therefore the interval is [**48.483413929021985, 151.516586070978]**

**Therefor option D is correct.**

**Or** we directly solve as,

**stats.norm.interval(0.99,loc=100,scale=20) = (48.483413929, 151.5165860)**

1. Consider a company that has two different divisions. The annual profits from the two divisions are independent and have distributions Profit1 ~ N(5, 32) and Profit2 ~ N(7, 42) respectively. Both the profits are in $ Million. Answer the following questions about the total profit of the company in Rupees. Assume that $1 = Rs. 45
2. Specify a Rupee range (centered on the mean) such that it contains 95% probability for the annual profit of the company.
3. Specify the 5th percentile of profit (in Rupees) for the company
4. Which of the two divisions has a larger probability of making a loss in a given year?

Mean profits from two different divisions of a company = Mean1 + Mean2

Mean = 5+7=12

print('Mean Profit is Rs', Mean\*45,'Million') (ie 12\*45)

= Mean Profit is Rs 540 Million

And Variance of profits from two different divisions of a company

= SD^2 = SD1^2 + SD2^2

SD = np.sqrt((9)+(16))

print('Standard Deviation is Rs', SD\*45, 'Million') (ie 5\*45)

= Standard Deviation is Rs 225.0 Million

**A**) Specify a Rupee range such that it contains 95% probability for the annual profit of the company.

**stats.norm.interval(0.95,loc=540,scale=225**

**=(99.00810347848784, 980.9918965215122)**

**B)** Now to find 5th percentile of profit (in Rupees) for the company

Finding 5th percentile is to find x value for the probability 0.05

**So, stats.norm.ppf(0.05,loc=540,scale=225) = 169.9079339359186**

**c)**

Probability of Division 1 making a loss P(X<0)

**stats.norm.cdf(0,5,3) = 0.0477903522728147**

AND

Probability of Division 2 making a loss P(X<0)

**stats.norm.cdf(0,7,4)= 0.040059156863817086**

**So, first division making an large loss than 2nd.**